



NOTA

FIRST RECORDS OF *Oxidus gracilis* (C.L. Koch, 1847) FOR URUGUAY, WITH NOTES ON ITS NATURAL HISTORY AND DISTRIBUTION (POLYDESMIDA: PARADOXOSOMATIDAE)

Carolina Rojas-Buffet^{1,2*}, Miguel Simó¹ & Petra Sierwald³

¹Sección Entomología, Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay.

²Departamento de Ecología y Biología Evolutiva, Instituto de Investigaciones Biológicas Clemente Estable, Ministerio de Educación y Cultura, Montevideo Uruguay.

³Field Museum, Chicago, United States of America.

*Corresponding author: crojas@fcien.edu.uy

ABSTRACT

The millipede species *Oxidus gracilis* (Polydesmida: Paradoxosomatidae) is recorded for the first time in Uruguay. This constitutes the first record of the Order Polydesmida and the family Paradoxosomatidae for the country. The species was found in synanthropic environments. Data on its natural history and distribution in the country are included.

Key words: Greenhouse millipede, Exotic species, Neotropic.

RESUMEN

Primer registro de *Oxidus gracilis* (C.L. Koch, 1847), con notas sobre su historia natural y distribución (Polydesmida: Paradoxosomatidae). Se registra por primera vez para Uruguay la especie de milpiés *Oxidus gracilis* (Polydesmida: Paradoxosomatidae). Este constituye el primer registro del Orden Polydesmida y de la familia Paradoxosomatidae para el país. La especie fue encontrada en ambientes sinantrópicos. Se incluyen datos sobre su historia natural y de distribución en el país.

Palabras clave: Milpiés de invernadero, especie exótica, Neotrópico.

Diplopoda (millipedes) is the more diverse class of the Subphylum Myriapoda with 14686 accepted species (Sierwald & Spelda, 2020). They are abundant in litter and soil and have an important role in decomposition processes, as well as environmental quality indicators (Minelli, 2015).

The order Polydesmida Leach, 1815 is the largest one containing more than 5000 nominal species (Shear

et al., 2016). It is characterized by the lack of eyes and the body rings carrying lateral keels known as paranota (Enghoff *et al.*, 2015).

Paradoxosomatidae Daday, 1889 is one of the largest millipede family with 198 genera and 975 species (Enghoff *et al.*, 2015). It is characterized by having paranota 2 lower than collum and paranota 3 (Enghoff *et al.*, 2015). This family occurs in all continents, except North America and Antarctica, and is most diverse in Southeastern Asia (Nguyen & Sierwald, 2013). Several species of Paradoxosomatidae have spread from Asia to all parts of the world through trade and now they are synanthropic (Enghoff *et al.*, 2015). One of them, the hothouse *Oxidus gracilis* (C.L. Koch, 1847) is native to East Asia, and now widespread due to commercial activities (Hoffman, 1999; Nguyen & Sierwald, 2013; Nguyen *et al.*, 2017). Populations of *O. gracilis* are mostly found in greenhouses worldwide and are widely registered for United States, Europe, Australia, and Central America (Hoffman, 1999; Suriel, 2012; Nguyen & Sierwald, 2013; Jovanovi *et al.*, 2016). In South America it has been cited for Peru (Kraus, 1955), Chile (Chamberlin, 1957), Brazil (Schubart, 1942, 1947; Boock & Lordello, 1952; Lordello, 1954; Santos da Silva *et al.*, 2001; Iniesta *et al.*, 2020) and Argentina (Mauriés, 1998; Agnolin *et al.*, 2019). *O. gracilis* differs from other Paradoxosomatidae species also widely distributed by trade, and from its congeners by morphological differences of the male modified walking legs used for sperm transfer, the gonopods (Suriel, 2012; Nguyen *et al.*, 2017).

The Uruguayan millipedes are poorly known and there are only six registered species (Sierwald & Spelda, 2020), none of them belonging to the order Polydesmida. Based on the revision of Diplopoda material from scientific collections of the country, specimens of *O. gracilis* were identified. This is the



Fig. 1. *Oxidus gracilis* from Uruguay. **A.** Male habitus. **B.** Male in spiral defense position. Photographs: Sofía Clavijo. Scale: 5 mm.

first time that the order Polydesmida, the family Paradoxosomatidae and the species *O. gracilis* are reported for Uruguay.

We studied the material deposited in the collections of two institutions: Facultad de Ciencias (FCE-Myr), Universidad de la República, Montevideo, Uruguay and Museo de Historia Natural (MNHN), Ministerio de Educación y Cultura, Montevideo, Uruguay. Additionally, we surveyed several sites of the country: natural and modified areas. The identification of the specimens was based on Nguyen *et al.* (2017). Gonopods were dissected and mounted in gel alcohol as temporary microscopic preparations and observed under microscope. Images of gonopods were made with NIKON D3500 camera, and the ones of the living specimens were made with an Olympus Tough TG-4 digital camera. The distribution map was made using SimpleMapp (Shorthouse, 2010).

Order Polydesmida Leach, 1813
 Family Paradoxosomatidae Daday, 1889
 Tribe Sulciferini Jeekel, 1968
 Genus *Oxidus* Cook, 1911
Oxidus gracilis (C.L. Koch, 1847)

Material examined: URUGUAY: *Florida*, Florida City, 34°05'55.1"S; 56°13'10.8"W, 13 December 2018, leg. W. Serra, 2 ♂♂, 1 ♀ (FCE-Myr 0673); *Mendoza Chico*, 34°13'55.2"S; 56°13'10.9"W, 16 February 2014, leg. W. Serra, 6 ♂♂, 2 ♀♀ (MNHN 53); October 2014, leg. W. Serra, 1 ♀♀, 3 juveniles (MNHN 46); 11 September 2016, leg. W. Serra, 1 ♀, 9 juveniles (MNHN 36). *Maldonado*, Near Aiguá City 34°13'30.7"S; 54°44'14.1"W, 3 February 2015, leg. W. Serra, 21 ♂♂,

19 ♀♀, 2 juveniles (MNHN 54). *Montevideo*, Facultad de Ciencias, Universidad de la República, 34°52'57.1"S; 56°07'05.8"W, 10 May 2014, leg. A. Benítez & S. García, 1 ♀ (FCE-Myr 0575); 08 July 2020, leg. M. Simó & cols., 1 ♂ (FCE-Myr 0691); Instituto de Investigaciones Biológicas Clemente Estable, Ministerio de Educación y Cultura, 34°53'15.2"S; 56°08'33.0"W, 06 April 2018, leg. C. Rojas, 1 ♂, 1 ♀ (FCE-Myr 0627); 2 October 2018, leg. D. Hagopían, 1 ♀ (FCE-Myr 0651); *Melilla* neighborhood, 34°43'25.8"S; 56°19'52.1"W, 24 December 2018, leg. D. Hagopían, 2 ♀♀ (FCE-Myr 0685).

Description: Body coloration of living male and female specimens: dark brown with yellowish paranota and legs (Fig. 1). Transverse groove present in the tergum of most segments, a common feature in most paradoxosomatids. Measurements: males (N=17): body length: 24.4–28.7 mm; body width: 2.0–2.6 mm; females (N=15): body length: 22.0–29.0 mm; body width: 2.1–2.6 mm. Gonopods such as those described in Nguyen *et al.* (2017): femorite "fe" intensely expanded to the distal part; postfemoral lamina "l" rectangular shaped; postfemoral spine "z" spiky and tubercular shaped; postfemoral process "h" laminar and serrated towards disto-lateral part; bases of process "h" and spine "z" separated; mesal lobule of solenophore "sph" lamella shaped; tips of mesal lobule and solenophore circular at distal area (Fig. 2).

Distribution: Southern Uruguay: Florida, Maldonado and Montevideo departments (Fig. 3).

Natural history: Always associated with urban environments such as parks, gardens and houses. Usually found under vegetation, stones and dead trunks, walking on external house walls and among *Eucalyptus* firewood. Frequently more than one individual is found at the collection sites.

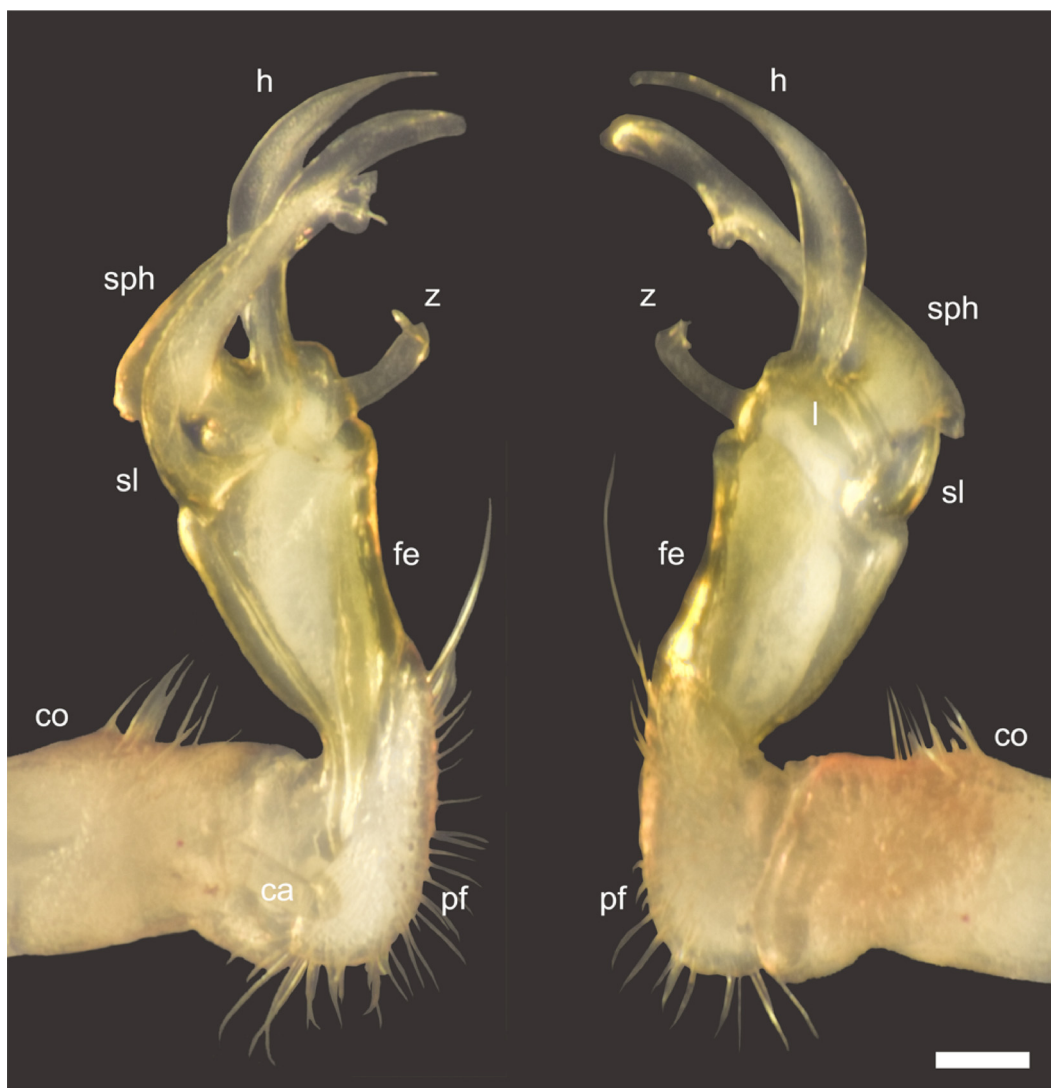


Fig. 2. Right gonopod of *Oxidus gracilis*. **A.** Mesal view. **B.** Lateral view. Gonopod nomenclature taken from Nguyen *et al.* (2017): ca = cannula; co = coxa; pf = prefemorite; fe = femorite; l = postfemoral lamina; z = postfemoral spine; h = postfemoral process; sl = solenomere; sph = solenophore. Photo: Damián Hagopíán. Scale: 100 μ m.

O. gracilis was found inhabiting synanthropic areas like parks, gardens and houses. This is in agreement with several reports from other parts of the world, which found this species associated with disturbed environments (Stoev *et al.*, 2010; Suriel, 2012; Nguyen & Sierwald, 2013; Nguyen *et al.*, 2017; Agnolin *et al.*, 2019). The fact that *O. gracilis* was not found in natural environments, confirms the positive effects of human impact in the dispersion and establishment of this cosmopolitan species.

It is difficult to specify the way and time that this species was introduced in the country, but probably it should have been accidentally through the trade

of ornamental plants and agriculture as it was reported for other countries (Suriel, 2012; Nguyen & Sierwald, 2013). The first collection record is from 2014, but considering that the presence of the species in South America is known from middle twenty century and that millipedes have been poorly surveyed in Uruguay, the introduction to this country could be oldest.

O. gracilis has been registered only for the south of the country. This also is common in others Uruguayan arthropod groups (Simó, 2005), on which most data records came from this region of the country, where is situated the capital city, others urban centers and the



main commercial and touristic places. According with studies in major taxonomic groups, sampling efforts had been focused in cities or near them, mainly because of scarce of financial support (Oliveira *et al.*, 2016). Recently, Iniesta *et al.* 2020, using species distribution models, reported the potential invasion of *O. gracilis* in different parts of Brazil. For the model, Pampa was predicted as a medium suitable area for the establishment of the species. In the future it would be interesting to increase the knowledge about the distribution and sites where this species lives in other parts of Uruguay and its potential invasion in natural areas.

We thank Wilson Serra, curator of the arthropod collection of the Museo de Historia Natural, for the loan of *O. gracilis* material. We are grateful to Sofía Clavijo and Damián Hagopían for the photographs of the living specimens and the gonopods respectively. We thank the Comisión Académica de Posgrado (CAP)

and the Programa de Desarrollo de las Ciencias Básicas (PEDECIBA) for the financial support. We also thanks two anonymous reviewers for the careful reading of the manuscript and their insightful comments and suggestions.

BIBLIOGRAPHY

- Agnolin F.L, Agnolin A. & Guerrero E.L. 2019. Invertebrados exóticos nuevos o poco conocidos en la Ciudad de Buenos Aires. *Acta Zoológica Lilloana*, 63 (2): 48-67.
- Boock O.J. & L.G.E. Lordello. 1952. Diplópoda depredador de tubérculos de batatinha. *Bragantia*, 12(10-12): 343-348.
- Chamberlin R.V. 1957. The Diplopoda of the Lund University and California Academy of Sciences expeditions. *Lund Universitets Arsskrift*, Ny Förlag, Avd. 2, 53(8): 1-44. Lund.
- Enghoff H., Golovatch S., Short M., Stoev P. & T.

- Wesener. 2015. Diplopoda: Taxonomic overview. In: Minelli A. (Ed.) Treatise on Zoology - Anatomy, Taxonomy, Biology. The Myriapoda, Volume 2, pp. 363-453. Brill Leiden, Boston.
- Hoffman R.L. 1999. Checklist of the millipeds of North and Middle America. Virginia Museum of Natural History, Martinsville, Virginia: Estados Unidos.
- Iniesta L.F.M., Bouzan R.S., Rodrigues P.E.S, Almeida T.M., Ott R. & A.D. Brescovit. 2020. Ecological niche modeling predicting the potential invasion of the non-native millipede *Oxidus gracilis* (C. L. Koch, 1847) (Polydesmida: Paradoxosomatidae) in Brazilian Atlantic Forest. *Annales de la Société entomologique de France* (N.S.), 2020. DOI: 10.1080/00379271.2020.1834873.
- Jovanovi Z.S., Anti D.A. & V.T. Tomi. 2016. First report of the millipede *Oxidus gracilis* (Diplopoda, Polydesmida, Paradoxosomatidae) in Serbia. *Kragujevac Journal of Science*, 38: 173-176.
- Kraus O. 1955. Myriapoden aus Peru, III. *Senckenbergiana biologica*, 36: 173-200. Frankfurt am Main.
- Lordello L.G.E. 1954. Observação sobre alguns Diplópodos de interesse agrícola. *Anais Da Escola Superior De Agricultura "Luiz De Queiroz"*, 11: 69-76.
- Mauriés J.P. 1998. Diplopoda. In: Morrone J.J., Coscarón S. (Eds.) Biodiversidad de artrópodos Argentinos. Una perspectiva biotaxonomía. Ediciones Sur. La Plata, Buenos Aires.
- Minelli A. 2015. Diplopoda: an outline of research history. In: Minelli A. (Ed.) Treatise on Zoology - Anatomy, Taxonomy, Biology. The Myriapoda, Volume 2, pp. 7-67. Brill Leiden, Boston.
- Nguyen A.D. & P.Sierwald. 2013. A worldwide catalog of the family Paradoxosomatidae Daday, 1889 (Diplopoda: Polydesmida). *Check List*, 9(6): 1132-1353.
- Nguyen A.D., Korsós Z., Jang K.-H. & U.-W. Hwang. 2017. A revision and phylogenetic analysis of the millipede genus *Oxidus* Cook, 1911 (Polydesmida, Paradoxosomatidae). *European Journal of Taxonomy*, 293: 1-22.
- Oliveira U., Pereira Paglia A., Brescovit A.D., de Carvalho C.J.B., Silva D.P., Rezende D.T., Sa Fortes Leite F., Nogueira Batista J.A., Peixoto Pena Barbosa J.P., Stehmann J.R., Ascher J.S., Ferreira de Vasconcelos M., De Marco Jr P., Lowenberg-Neto P., Guimaraes Dias P., Gianluppi Ferro V. & A.J. Santos. 2016. The strong influence of collection bias on biodiversity knowledge shortfalls of Brazilian terrestrial biodiversity. *Diversity and Distributions*, 22: 1232-1244.
- Santos da Silva R., Silva Pentead C.H. & L. Boccardo. 2001. Relações fisioecológicas no diplópodo *Oxidus gracilis* (Polydesmida, Strongylosomidade): o consumo de oxigênio em relação ao tamanho, sexo, e condição alimentar. *HOLOS Environment*, 1(1): 67-82.
- Schubart O. 1942. Os Myriápodes e suas relações com a agricultura. *Papéis Avulsos do Departamento de Zoologia*, 22(16): 205-234.
- Schubart O. 1947. O elemento 'Synanthropo' e estrangeiro entre os Diplopoda do Brasil. *Arthropoda*, 1: 23-40.
- Sierwald P. & J. Spelda. 2020. MilliBase. Accessed at <http://www.millibase.org> on 2020-09-10. doi:10.14284/370.
- Shear W.A., Lopes Ferreira R., Moreti Iniesta L.F. & P. Marek. 2016. A millipede missing link: Dobrodesmidae, a remarkable new polydesmidan millipede family from Brazil with supernumerary rings (Diplopoda, Polydesmida), and the establishment of a new suborder Dobrodesmidea. *Zootaxa*, 4178 (3): 371–390.
- Shorthouse D.P. 2010. Simple Mappr, an online tool to produce publication-quality point maps. <<http://www.simplemappr.net>>. Accessed 10 July 2020.
- Simó M. 2005. La sistemática del orden Araneae y consideraciones acerca de su estudio en el Uruguay. In: A. Langguth (Ed.) Biodiversidad y Taxonomía. Presente y futuro en el Uruguay. Unesco, Montevideo, Uruguay.
- Stoep P., Zapparoli M., Golovatch S., Enghoff H., Akkari N. & A. Barber. 2010. Myriapods (Myriapoda). Chapter 7.2. In: Roques A., Kenis M., Lees D., Lopez-Vaamonde C., Rabitsch W., Rasplus J.-Y., Roy B.D. (Eds) Alien terrestrial arthropods of Europe, pp. 97-130. *BioRisk*, Special Issue.
- Suriel C. 2012. Presencia de *Oxidus gracilis*, *Chondromorpha xanthotricha* y *Asiomorpha coarctata* (Diplopoda: Paradoxosomatidae) en La Hispaniola. *Solenodon*, 10: 23-31.

Fecha de Recepción: 14 de septiembre de 2020
Fecha de Aceptación: 01 de diciembre 2020